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Courses » Estimation for Wireless Communications – MIMO/OFDM Cellular and Sensor Networks

Announcements Course Ask a Question Progress

Unit 5 - Week 4 - Least Squares (LS) Principle, Pseudo-Inverse, Properties of LS Estimate, Examples – Mullti-Antenna Downlink and MIMO Channel Estimation

Assignment-4

The due date for submitting this assignment has passed. **Due on 2017-08-20, 23:59 IST.**
As per our records you have not submitted this assignment.

1) Consider the maximum likelihood (ML) multi-antenna channel estimation problem with N transmitted pilot vectors $\mathbf{x}(k) = [x_1(k), x_2(k), \ldots, x_M(k)]^T$, $1 \leq k \leq N$ and N received symbols $y(1), y(2), \ldots, y(N)$. Let the channel vector be $\mathbf{h} = [h_1, h_2, \ldots, h_M]^T$. Let the pilot matrix be $\mathbf{X}$. The ML estimate of $\mathbf{h}$ is, ***1 point***

- $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$
- $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{h}$
- $\mathbf{X}^{-1}\mathbf{y}$
- $(\mathbf{X}\mathbf{X}^T)^{-1}\mathbf{X}^T\mathbf{y}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$

2) Consider a multi-antenna channel estimation scenario with $N = 4$ pilot vectors $\mathbf{x}(1) = [3, 2]^T, \mathbf{x}(2) = [-2, 1]^T, \mathbf{x}(3) = [-1, -2]^T, \mathbf{x}(4) = [-1, 3]^T$. Let the corresponding received vector be $\mathbf{y} = [3, 2, 2, 1]^T$. Let the dB noise variance be $-4.77dB$. The corresponding pilot matrix $\mathbf{X}$ is, ***1 point***

- $$\begin{bmatrix} 3 \\ 2 \\ -2 \\ 1 \\ -1 \\ -2 \\ -1 \\ 3 \end{bmatrix}$$
-

$$\begin{bmatrix} 3 & 2 \\ -2 & 1 \\ -1 & -2 \\ -1 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 3 & -2 & -1 & -1 \\ 2 & 1 & -2 & 3 \end{bmatrix}$$

$$[3 \;\; 2 \;\; -2 \;\; 1 \;\; -1 \;\; -2 \;\; -1 \;\; 3]$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{bmatrix} 3 & 2 \\ -2 & 1 \\ -1 & -2 \\ -1 & 3 \end{bmatrix}$$

3) Consider a multi-antenna channel estimation scenario with $N = 4$ pilot vectors $\mathbf{x}(1) = [3, 2]^T, \mathbf{x}(2) = [-2, 1]^T, \mathbf{x}(3) = [-1, -2]^T, \mathbf{x}(4) = [-1, 3]^T$. Let the corresponding received vector be $\mathbf{y} = [3, 2, 2, 1]^T$. Let the dB noise variance be $-4.77dB$. The pseudo-inverse of the pilot matrix $\mathbf{X}$ is, ***1 point***

$$\frac{1}{87}\begin{bmatrix} 16 & -13 & -4 & -9 \\ 7 & 7 & -9 & 16 \end{bmatrix}$$

$$\frac{1}{87}\begin{bmatrix} -11 & 17 & 14 & 21 \\ 5 & -27 & 9 & 12 \end{bmatrix}$$

$$\frac{1}{87}\begin{bmatrix} 42 & 32 \\ -29 & 16 \\ -21 & -72 \\ -16 & 38 \end{bmatrix}$$

$$\frac{1}{87}\begin{bmatrix} 33 & -23 & 8 & 25 \\ 12 & -14 & 34 & -45 \end{bmatrix}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\frac{1}{87}\begin{bmatrix} 16 & -13 & -4 & -9 \\ 7 & 7 & -9 & 16 \end{bmatrix}$$

4) Consider a multi-antenna channel estimation scenario with $N = 4$ pilot vectors $\mathbf{x}(1) = [3, 2]^T, \mathbf{x}(2) = [-2, 1]^T, \mathbf{x}(3) = [-1, -2]^T, \mathbf{x}(4) = [-1, 3]^T$. Let the corresponding received vector be $\mathbf{y} = [3, 2, 2, 1]^T$. Let the dB noise variance be $-4.77dB$. The estimate of the channel vector $\mathbf{h}$ is, ***1 point***

$$\frac{1}{87}\begin{bmatrix} 68 \\ 32 \end{bmatrix}$$

$$\frac{1}{87}\begin{bmatrix} 21 \\ 17 \end{bmatrix}$$

Scalar/ Vector Cases, Applications - Wireless Fading Channel Estimation, SLS Example

$\frac{1}{87}\begin{bmatrix} -12 \\ 45 \end{bmatrix}$

$\frac{1}{87}\begin{bmatrix} 5 \\ 33 \end{bmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{1}{87}\begin{bmatrix} 5 \\ 33 \end{bmatrix}$

5) Consider a multi-antenna channel estimation scenario with $N = 4$ pilot vectors $\mathbf{x}(1) = [3,2]^T, \mathbf{x}(2) = [-2,1]^T, \mathbf{x}(3) = [-1,-2]^T, \mathbf{x}(4) = [-1,3]^T$. Let the corresponding received vector be $\mathbf{y} = [3,2,2,1]^T$. Let the dB noise variance be $-4.77dB$. The covariance of the ML estimate is, ***1 point***

$\frac{1}{261}\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$

$\begin{bmatrix} \frac{1}{3} & 0 \\ 0 & \frac{1}{3} \end{bmatrix}$

$\frac{1}{261}\begin{bmatrix} 6 & 0 \\ 0 & 5 \end{bmatrix}$

$\frac{1}{261}\begin{bmatrix} 6 & -1 \\ -1 & 5 \end{bmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{1}{261}\begin{bmatrix} 6 & -1 \\ -1 & 5 \end{bmatrix}$

6) Consider a multi-antenna channel estimation scenario. In general, when are the estimation errors of the various channel coefficients uncorrelated for a scenario with IID noise samples of variance σ^2 each? ***1 point***

- When the pilot matrix is square
- When the pilot matrix is invertible
- When the columns of pilot matrix are orthogonal
- None of the above

No, the answer is incorrect.
Score: 0

Accepted Answers:
When the columns of pilot matrix are orthogonal

7) Consider a multi-antenna channel estimation scenario with $N = 3$ pilot vectors $\mathbf{x}(1) = [1,2]^T, \mathbf{x}(2) = [3,-1]^T, \mathbf{x}(3) = [1,1]^T$. Let the corresponding received vector be $\mathbf{y} = [2,1,2]^T$. The pseudo-inverse of the pilot matrix $\mathbf{X}$ is, ***1 point***

$\begin{bmatrix} \frac{1}{11} & \frac{3}{11} & \frac{1}{11} \\ \frac{1}{3} & -\frac{1}{6} & \frac{1}{6} \end{bmatrix}$

$$\begin{bmatrix} 1 & 3 & 1 \\ 2 & -1 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \frac{2}{11} & -\frac{3}{11} & -\frac{1}{11} \\ \frac{1}{3} & \frac{1}{6} & -\frac{1}{6} \end{bmatrix}$$

$$\begin{bmatrix} \frac{2}{6} & -\frac{3}{6} & -\frac{1}{6} \\ \frac{1}{11} & \frac{1}{11} & -\frac{1}{11} \end{bmatrix}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{bmatrix} \frac{1}{11} & \frac{3}{11} & \frac{1}{11} \\ \frac{1}{3} & -\frac{1}{6} & \frac{1}{6} \end{bmatrix}$$

8) Consider a multi-antenna channel estimation scenario with $N = 3$ pilot vectors $\mathbf{x}(1) = [1, 2]^T, \mathbf{x}(2) = [3, -1]^T, \mathbf{x}(3) = [1, 1]^T$. Let the corresponding received vector be $\mathbf{y} = [2, 1, 2]^T$. The ML estimate of the channel is given as *1 point*

$$\begin{bmatrix} \frac{7}{11} \\ \frac{5}{6} \end{bmatrix}$$

$$\begin{bmatrix} \frac{6}{11} \\ \frac{1}{6} \end{bmatrix}$$

$$\begin{bmatrix} \frac{5}{6} \\ \frac{1}{11} \end{bmatrix}$$

$$\begin{bmatrix} \frac{5}{6} \\ -\frac{1}{11} \end{bmatrix}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{bmatrix} \frac{7}{11} \\ \frac{5}{6} \end{bmatrix}$$

9) Consider a multi-antenna channel estimation scenario with $N = 3$ pilot vectors $\mathbf{x}(1) = [1, 2]^T, \mathbf{x}(2) = [3, -1]^T, \mathbf{x}(3) = [1, 1]^T$. Let the corresponding received vector be $\mathbf{y} = [2, 1, 2]^T$. Let the dB noise variance be $3dB$. The covariance of the ML estimate is, *1 point*

$$\begin{bmatrix} \frac{1}{11} & 0 \\ 0 & \frac{1}{6} \end{bmatrix}$$

$$\begin{bmatrix} \frac{2}{11} & 0 \\ 0 & \frac{2}{6} \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 2 \\ 2 & 2 \end{bmatrix}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{bmatrix} \frac{2}{11} & 0 \\ 0 & \frac{2}{6} \end{bmatrix}$$

10) Consider a multi-antenna channel estimation scenario with $N = 3$ pilot vectors $\mathbf{x}(1) = [1, 2]^T, \mathbf{x}(2) = [3, -1]^T, \mathbf{x}(3) = [1, 1]^T$. The correlation between the estimation errors of the individual channel coefficients is, ***1 point***

- 1
- 11
- 6
- 0

No, the answer is incorrect.
Score: 0

Accepted Answers:
0

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